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AROMATHERAPY POSITIVELY AFFECTS MOOD, EEG PATTERNS OF ALERTNESS AND MATH COMPUTATIONS*

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EEG activity, alertness, and mood were assessed in 40 adults given 3 minutes of aromatherapy using two aromas, lavender (considered a relaxing odor) or rosemary (considered a stimulating odor). Participants were also given simple math computations before and after the therapy. The lavender group showed increased beta power, suggesting increased drowsiness, they had less depressed mood (POMS) and reported feeling more relaxed and performed the math computations faster and more accurately following aromatherapy. The rosemary group, on the other hand, showed decreased frontal alpha and beta power, suggesting increased alertness. They also had lower state anxiety scores, reported feeling more relaxed and alert and they were only faster, not more accurate, at completing the math computations after the aromatherapy session.

Keywords: Aromatherapy; EEG; cognition; mood; lavender; rosemary

Aromas have been used throughout history for their medicinal and mood altering properties. Aroma molecules have direct effects on human behavior and physiology ranging from activation of memories to changes in mood or

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emotional states. Although much of what we know about these effects comes from anecdotal rather than empirical evidence (Buchbauer, Jirovetz, Jager, Plank and Dietrich, 1993, Valnet, 1986), these effects may be explained by the close association between the olfactory and limbic systems (see Bear, Connors and Paradiso, 1996 and Lindsley and Holmes, 1984 for reviews).

Aromatherapy has been rapidly gaining popularity. The essential oils involved in aromatherapy are highly concentrated essences extracted from plants through the process of distillation. Each oil is said to produce a predictable and reproducible effect on the user when its fragrance is inhaled (Sanderson and Ruddle, 1992; Valnet, 1986). Lorig and Schwartz (1987b; 1988) found, for example, that certain essential oils (lavender, spiced apple and eucalyptus) modified EEG activity including increasing relaxation as suggested by increases in alpha power. In another study Lorig and colleagues (Lorig, Herman, Schwartz and Cain, 1990), found that frontal beta EEG activity increased during lavender and decreased during spiced apple presentation. Parasuraman, Warm and Dember (1992) found that subjects exposed to a peppermint aroma were better able to sustain attention as assessed by an increase in skin conductance levels and sustained event related potential N160 amplitude across the attention task. Other studies have supported these EEG findings. For example Badia and colleagues recorded high frequency bursts in the EEG of subjects who were presented a peppermint aroma during sleep (Badia, Wesensten, Lammers, Culpepper and Harsh, 1990). Aromatherapy research has also shown behavioral changes including improved mood following presentation of chamomile oil (Roberts and Williams, 1992), positive affect while smelling vanillin (Miltner, Matjak, Diekmann and Brody, 1994), enhanced attention and performance on visual vigilance tasks following presentation of peppermint aroma (Warm, Dember and Parasuraman, 1991) and decreased anxiety and tension following lavender, spiced apple or eucalyptus aroma presentation (Lorig and Schwartz, 1987b).

The present study examined aromatherapy effects on feelings of relaxation, anxiety, mood and alertness and on EEG activity and math computations. Two aromas were examined, an alerting odor (rosemary) and a relaxing odor (lavender). After the aromatherapy session the subjects who experienced the lavender aroma were expected to report less anxiety, better mood, and to show an increase in EEG power in the alpha and beta bands suggesting increased relaxation. In contrast, subjects who were presented the rosemary aroma were expected to show greater alertness as suggested by decreased alpha and beta power and better performance on the math

computations. For example, in a previous EEG study subjects who were given massage therapy: (1) showed a decrease in frontal alpha and beta power (suggesting alertness), (2) showed an increase in frontal delta power (suggesting relaxation), (3) reported feeling better and (4) performed better in a cognitive task (Field *et al.*, 1996).

METHOD

Participants

The subjects were 40 faculty and staff members of the University of Miami Medical School (30 females, 10 males, M age = 30.9). They were middle socioeconomic status (M = 2.7 on the Hollingshead) and were 43% white, 15% African American, and 42% hispanic. The participants were randomly assigned to the lavender or rosemary aroma conditions. The groups did not differ on the above demographic variables.

Aromatherapy Procedure

The aromatherapy was given by a research assistant to subjects seated in a special massage chair. Three drops of Lavender or Rosemary essential oil diluted to 10% concentration in grapeseed oil (provided by Aromatherapy Associates, Inc.) were placed on a cotton dental swab and presented in a 100 ml plastic vial which the subjects held about 3 inches from their nose for a period of three minutes. Subjects were instructed to breathe normally through their noses and sit quietly with their eyes closed.

Assessment

The assessments were conducted in the following order: (1) the *EEG cap* was positioned on the subject's head; (2) the subjects completed the session baseline measures, including the *demographic questionnaire*, the *State Anxiety Inventory* (STAI; Spielberger, Gorsuch and Luschene, 1970), the *Profile of Mood States* (POMS; McNair, Lorr and Droppleman, 1971), the *tense/relaxed and drowsy/alert visual analogue mood scales*, and the *math computations*; (3) then the *aromatherapy* was given; and (4) immediately after the aromatherapy, the subjects completed another math computation, the POMS depression scale and the STAI to assess anxiety.

Self-report Measures

The following measures were taken before and after the therapy sessions: The STAI (Spielberger *et al.*, 1970), is a 20 item scale that measures transitory anxiety levels in terms of severity, with 1 representing not so much and 4 representing very much. Characteristic items include: "I feel tense and I feel relaxed." The STAI has adequate concurrent validity (Spielberger, 1972) and internal consistency ($r = 0.83$; Spielberger *et al.*, 1970). In addition, the STAI state scores an increase in response to situational stress and a decline under relaxing conditions. A summary score is obtained by adding the weight of each item.

The POMS (McNair *et al.*, 1971) is a 5-point adjective Likert rating scale asking the participants to describe how well an adjective describes their current feelings. The items that comprise the depression and anxiety factors were used. This scale has adequate internal consistency ($r = 0.95$; McNair and Lorr, 1964) and is an adequate measure of intervention effectiveness (Pugtach, Haskell and McNair, 1969). A summary score is obtained by adding the weight of each item.

Two visual analogue scales (tense/relaxed and drowsy/alert) involved the subjects circling the number (on a 10 point ordinal scale) corresponding to the way they felt at that moment. On the tense-relaxed scale a score of 0 was assigned to feeling "very tense" and a score of 10 to being "very relaxed". On the drowsy-alert scale a score of 0 was assigned to feeling "very drowsy" and a score of 10 to feeling "very alert".

Math Computations

Before and after the aromatherapy session, participants were given math computations involving averaging a series of 7 single digit numbers. The time needed to complete the computation and the accuracy of the response was recorded. This measure was used to determine whether the alerting effects attributed to rosemary would translate into superior performance.

EEG Procedure

EEG was considered the primary dependent variable in this study as the physiological measure of relaxation and alertness. EEG was recorded for 3 minute periods prior to, during and after the therapy sessions, with the

subjects' eyes closed. The EEG was recorded using a lycra stretchable cap (Electro-Cap, Inc.) that was positioned on the subject using the standard 10–20 system. Electrode gel was inserted into the midfrontal (F3 and F4) and parietal (P3 and P4) sites and referenced to the vertex (Cz). Impedances were brought below 5 K ohms. The EEG signals were amplified using a Grass Model 12 Neurodata Acquisition System. The output from the amplifiers was directed to a Dell 325 PC fitted with an Analog Devices RTI-815 A/D/board. The signal was sampled at a rate of 512 samples per second and streamed onto the computer screen and then saved to a hard drive using Snapstream software (HEM Data Corporation).

The EEG data were edited for artifact using software designed by James Long Inc. The artifact-free data were spectrally analyzed using a discrete Fourier transform with a Hanning window with 50% overlap to yield power values for the following frequency bands: 1–4 Hz (Delta); 5–7 Hz (Theta); 8–12 Hz (Alpha); 13–20 Hz (Low Beta) and 21–30 Hz (High Beta).

RESULTS

Self Report Data

A significant group (Lavender/Rosemary) by time (per/post) repeated measures MANOVA followed by ANOVAS and subsequent post hoc Bonferroni corrected *t*-tests revealed the following (Tab. I): (1) a repeated measures effect ($F(1, 37) = 3.39$, $p < 0.05$) revealed a significant decrease in the State Anxiety scores of both groups; (2) a group by time effect ($F(1, 37) = 8.64$, $p < 0.01$) revealed that only the lavender group had significantly better mood (lower POMS scores) after the aroma session; (3) a repeated measured effect ($F(1, 37) = 15.58$, $p < 0.001$) revealed that both groups were feeling more relaxed and; (4) a group by time marginal effect ($F(1, 37) = 3.38$, $p < 0.1$) revealed a trend for the rosemary group to report feeling more alert.

Math Computations

Group (lavender/rosemary) by time (pre/post) time ANOVAS revealed time effects (Tab. I) which suggested that while both groups completed the math computations faster ($F(1, 38) = 11.64$, $p \leq 0.005$), only the lavender group's accuracy scores improved ($F(1, 37) = 4.80$, $p \leq 0.05$).

TABLE I Means for lavender and rosemary group measures (S.D.s in parentheses under means)

	Lavender N = 20		*Rosemary N = 20*		
Measure	*Pre*	*Post*	*Pre*	*Post*	*Effects*
State Anxiety[#]	34.32_a (9.53)	31.21_b (8.75)	33.30_a (9.33)	26.30_b (5.91)	T[†]
Depressed Mood[#]	2.66_a (2.63)	1.16_b (1.64)	1.45_b (3.05)	1.74_b (3.73)	G × T[‡] T*
Tense-Relaxed	6.10_a (2.47)	7.68_b (2.02)	7.00_a (2.39)	8.70_b (1.34)	T[§]
Drowsy-Alert	6.16_a (2.91)	5.95_a (2.71)	6.00_a (2.34)	7.30_b (1.62)	G × T*
Computation Time[#]	5.14_a (1.80)	4.49_b (1.94)	5.23_a (1.75)	4.52_b (1.26)	T[¶]
Computation Accuracy	2.55_a (1.79)	3.10_b (1.59)	2.25_a (1.83)	2.50_b (1.64)	T[†]

* $p \leq 0.1$, [†]$p \leq 0.05$, [‡]$p \leq 0.01$, [¶]$p \leq 0.005$, [§]$p \leq 0.001$. [#]lower is optimal.

EEG Data

Following a significant repeated measures group (Lavender/Rosemary) by time (pre-/during/post) by region (frontal/parietal) MANOVA conducted on the log power values for the delta, theta, alpha, low beta, and high beta bands, analyses of variance revealed the following (see Tab. II for *F* values): (1) as expected, a group by time interaction for alpha revealed that frontal alpha power significantly increased after lavender, suggesting increased drowsiness, while frontal alpha power decreased from pre to during and pre to post after the rosemary, suggesting increased alertness; and (3) trial effects for frontal beta 2 power revealed an increase after lavender and rosemary presentation suggesting drowsiness.

DISCUSSION

The present study evaluated the effects of two commonly used odors on anxiety, mood, relaxation, alertness, math computations and EEG activity. Our findings support other research studies showing that certain aromas can positively influence mood (Roberts and Williams, 1992). The Lavender group reporting feeling more relaxed and their increase in beta power supports previous findings on lavender's ability increase frontal beta power (Lorig *et al.*, 1990), promote drowsiness (Buchbauer *et al.*, 1991) and induce

TABLE II Group by trial by region effects for frontal and parietal log power values SD's in parenthesis

	Pre	*During*	*Post*
	Alpha (8–12 *Hz*)		
Lavender	3.07_a(3.47)	3.40_a(2.90)	3.72_b* (2.74)
Rosemary	4.16_a(2.22)	3.74_b*** (2.15)	3.72_b* (2.41)
Group × Time – $F(1,37) = 2.588$ $p = 0.089$		Region $F(1,37) = 119.71$ $p = 0.000$	
	Beta 1(13–20 *Hz*)		
Lavender	0.57_a(3.35)	0.79_a(2.77)	0.96_a(2.67)
Rosemary	1.07_a(2.05)	0.96_b* (1.99)	1.14_a(2.11)
Region × Time – $F(1,37) = 4.772$ $p = 0.015$		Region $F(1,37) = 30.38$, $p = 0.000$	
	Beta 2(21–30 *Hz*)		
Lavender	-0.17_a(3.16)	0.06_a(2.58)	0.27_b*** (2.53)
Rosemary	0.53_a(1.76)	0.47_a(1.87)	0.80_b* (2.14)
Time $F(1,37) = 6.565$ $p = 0.004$			

* $p > 0.1$, ***$p > 0.001$

sleep (van Toller, 1988). Those who were exposed to the rosemary aroma showed increased alertness both by their self report and the decreases noted in Alpha and beta 1 power. These findings support the belief that rosemary is an alerting aroma (van Toller, 1988). The increase in frontal beta 2 power immediately after the rosemary aroma was removed suggests that its alerting effect might be short lived.

The math computation results suggest that although both groups performed the computations faster after the aroma session only the lavender group showed improved accuracy on math computations following the sessions. This finding was surprising because the lavender group did not show the enhanced alertness EEG pattern that the rosemary group showed. Perhaps as reflected in both self report and EEG data the lavender group was more relaxed and thus better able to concentrate. This and previous research indicate that aromas can effect psychological and physiological changes. Further research is needed on the underlying mechanisms of these effects.

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